

Local Oscillator Technologies for THz Instruments, Phase I

Completed Technology Project (2018 - 2019)



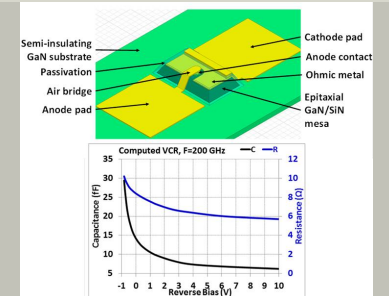
Project Introduction

Toyon is proposing to develop multiplier technology with record power handling in the 200 – 400 GHz output frequency range using Gallium Nitride (GaN) materials. This technology is needed to effectively utilize the high pump powers now available from mm-wave GaN power amplifiers. GaN has inherent material property advantages including high electric field strength, electron velocity, and thermal conductivity which will enable significant advances in multiplier power handling and performance, similar to how these material advantages led to advances in power amplifier technology. During this effort Toyon will analyze, optimize, and prototype novel GaN devices suited for this application. The prototypes will be characterized and modeled. Based on these models candidate multiplier designs will be investigated and analyzed. Toyon anticipates this technology will lead to mm-wave multipliers with input power handling over 1 watt and efficiency over 30%. It will be applicable to many CW signal source applications such as Terahertz local oscillators which are used in a wide range of mm-wave and THz systems including radio astronomy, spectroscopy, imaging, and communication systems.

Anticipated Benefits

Millimeter-wave multipliers will be of interest to NASA in a variety of commercial applications. The devices will provide robust, reliable, and efficient mm-wave power for next generation atmospheric monitoring satellites and radio astronomy telescopes. For example, the Global Precipitation Measurement System uses a 35.5 GHz radar paired with a Microwave Imager which can scan channels up to 183 GHz.

The Department of Defense is interested in THz imaging systems for the detection of concealed weapons. The medical industry is also interested in using THz imaging systems for burn wounds and cornea hydration. mm-Wave imaging is used for climate monitoring applications and measurements such as total precipitable water, snow cover, and sea ice extent. NOAA's Special Sensor Microwave Imager Sounder is a good example.



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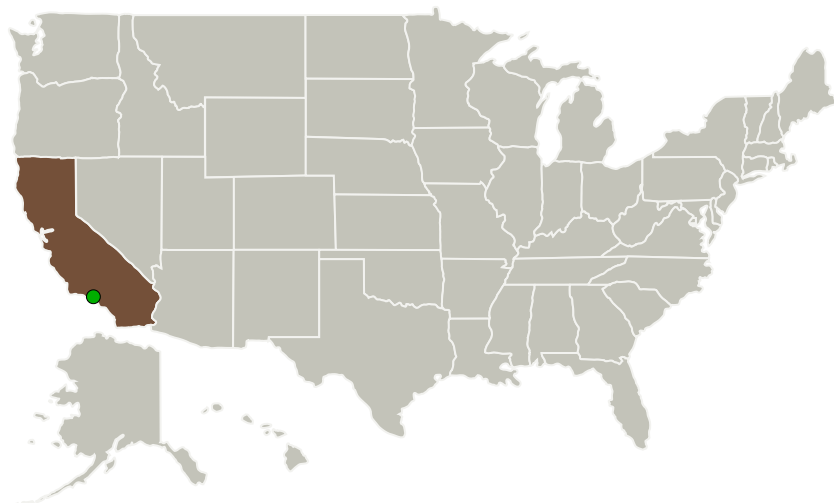
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Toyon Research Corporation	Lead Organization	Industry	Goleta, California
● Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations

California

Project Transitions

▶ **July 2018:** Project Start

✓ **February 2019:** Closed out

Closeout Documentation:

- Final Summary Chart PDF(<https://techport.nasa.gov/file/141153>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Toyon Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Managers:

Carol R Lewis
Robert A Jones

Principal Investigator:

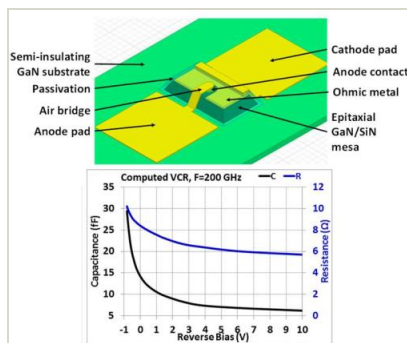
Tariq Mujahed

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**February 2019:** Closed out**Closeout Documentation:**

- Final Summary Chart(<https://techport.nasa.gov/file/141152>)

Images**Briefing Chart Image**

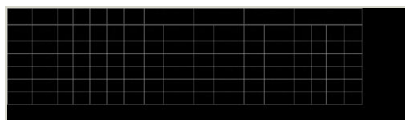
Local Oscillator Technologies for THz Instruments, Phase I

(<https://techport.nasa.gov/image/125853>)

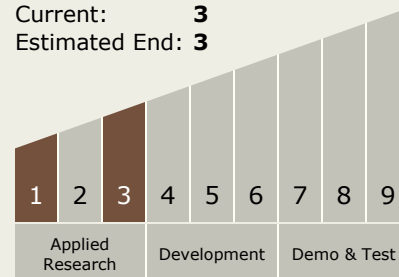
Design	Output cm ²	V _{DD} (V)	C _{gs} (fF)	R _{gs} (Ω)	C _{gs} (fF)	Q _{gs}	E.R. (%)			P _{in} (dBm)			P _{out} (dBm)			AWRDE Impedance matches			
							Prod.	AWRDE	Prod.	AWRDE	Prod.	AWRDE	Prod.	AWRDE	R _{in} (Ω)	R _{out} (Ω)	L _{in} (pH)	L _{out} (pH)	
1	7.10 ⁰	50	11.2	1.3	41	12.37	44.4	33	23.32	22.7	19.8	18	115	101	713	189			
2	7.10 ⁰	50	16.8	2.35	19	15.31	52	40	22.29	21.4	19.40	17.5	84	42	430	117			
3	7.10 ⁰	50	27	4.3	7	17.7	37	50	19.77	30	17.33	17	30	32	207	66			
4	7.10 ⁰	50	33.6	6.3	9.33	10.65	39.2	27.1	22.33	21.9	18.28	16.25	48	29	207	42			
5	7.10 ⁰	50	58.4	7.65	6.33	15.31	52	44	27.00	26.4	24.18	22.8	30.8	17	173	42			

Final Summary Chart Image

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(<https://techport.nasa.gov/image/126412>)**Final Summary Chart Image**

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(<https://techport.nasa.gov/image/131738>)**Technology Maturity (TRL)**Start: **1**Current: **3**Estimated End: **3****Target Destinations**

Earth, Outside the Solar System